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EXPLOSIVE DETECTION SYSTEMS DATA COLLECTION FINAL REPORT

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Contract No. FA4819-12-C-0007

October 2016

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14. ABSTRACT The report contained herein is the final report associated with contract FA4819-12-C-0007, Explosive Detection Systems Data Collection (EDSDC). This contract was the primary contract vehicle for conducting Home Made Explosive (HME) Data Collection work on behalf of the Department of Homeland Security (DHS), by ARA's Tyndall Reactive Materials Group (TRMG). In August 2013, this contract was modified to accommodate a joint DHS/National Institute of Standards and Technology (NIST) project to develop standards for bomb squad operators. Under this effort, ARA was tasked with developing and shipping robotic test methods, in close coordination with NIST, and under the direction of a DHS program manager. In March 2015, the Air Force Civil Engineer Center (AFCEC) at TAFB added a task for ARA to develop a robotic test method for the acquisition/procurement of a small backpack Explosive Ordnance Disposal (EOD) robot.					
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1. Contract Summary

The report contained herein is the final report associated with contract FA4819-12-C-0007, Explosive Detection Systems Data Collection (EDSDC), with the Period of Performance (POP) (as amended) of 05 March 2012 through 30 September 2016. This contract was the primary contract vehicle for conducting Home Made Explosive (HME) Data Collection work on behalf of the Department of Homeland Security (DHS), by ARA's Tyndall Reactive Materials Group (TRMG). At the point when a separate DHS contract was put in place (DTRA-L00066.00041, June 2012) to continue this work, the contract FA4819-12-C-0007 allowed DHS to complete the site work on the Tyndall Reactive Materials Site (TRMS), a DHS-leased area on Tyndall Air Force Base (TAFB). In August 2013, this contract was modified to accommodate a joint DHS-National Institute of Standards and Technology (NIST) project to develop standards for bomb squad operators. Under this effort, ARA was tasked with developing and shipping robotic test methods, in close coordination with NIST, and under the direction of a DHS program manager. In March 2015, the Air Force Civil Engineer Center (AFCEC) at TAFB added a task for ARA to develop a robotic test method for the acquisition/procurement of a small backpack Explosive Ordnance Disposal (EOD) robot. Once this task was completed, ARA completed the DHS/NIST task, developing and shipping robotic test methods for use by bomb squads at law enforcement and other first responder agencies. Funding was expended by the end of the POP (30 September 2016), with the exception of the funding required to complete this final report.

1.1. Contract Modifications

Thirteen modifications were issued during the life of this contract. The summary of these modifications are listed in Table 1.

Table 1. Contract Modifications

Mod No.	Effective Date	Summary of Modification
P00001	16 May 2012	Added incremental funding; Updated section 8002
P00002	28 Jun 2012	Changed DFAS pay office from DFAS Limestone to DFAS Columbus
P00003	29 Aug 2012	Extended Period of Performance (POP) from 30 Sep 2013 to 30 Jun 2013
P00004	22 Mar 2013	Added incremental funding; Updated section 8002; Changed the government program manager
P00005	28 Jun 2013	No-cost Extension (NCE) from 30 Jun 13 to 30 Sept
P00006	18 Sep 2013	Added incremental funding; Updated section 8002, Extended POP to 30 Sep 15
P00007	9 Dec 2014	Added language in section H006 for contractor labor reporting requirements
P00008	5 Jan 2015	Added incremental funding; Updated section 8002 and added section G005; Changed total funded amount; Changed unfunded amount
P00009	4 Mar 2015	Added incremental funding; Updated sections B002 and G005; Changed name of contractor program manager from Tom Dombrowsky to Bruce Hebert; Changed total funded amount; Changed unfunded amount
P00010	4 Mar 2015	Removed Government Furnished Property Clauses

P00011	17 Sep 2015	Added incremental funding, Updated sections B002 and G005; Added Government Furnished Property Clauses in accordance with FAR 45.107 and DFARS 245.107; Changed POP from 30 Sep 15 to 30 Sep 16; Changed total funded amount; Changed unfunded amount
P00012	8 Oct 2015	Correction to section G005 Payment Instructions
P00013	29 Jan 2016	Corrected section G005, Payment Instructions; Corrected the Administrative Office DoDAAC for DCMA Albuquerque

2. Introduction

This report summarizes the efforts under contract FA4819-12-C-0007, Explosive Detection Systems Data Collection. This project included of the following tasks over the life of the contract:

- Data collection on a variety of HME from EDS equipment provided by DHS, via the Transportation Security Laboratory (TSL).
- Development of the TRMS, a DHS operations site on TAFB's Silver Flag Exercise Site.
- Coordination with the NIST on behalf of DHS on developing standards for first responder robot operators, primarily civilian law enforcement bomb squads and fire rescue units.
- Acquisition of a small Explosive Ordnance Disposal (EOD) robot by collecting performance data of several candidate robotic systems, and by constructing a robotics course for use during the acquisition.

3. Task Summary

The following sub-sections explains the methods, assumptions and procedures for the tasks listed in this contract, listed chronologically.

3.1. DHS Support (Tyndall Reactive Materials Group)

ARA's initial task in support of this contract was to conduct data collection from various explosive detection systems (EDS) used in support of commercial aviation. From late March 2012 until early June 2012, nineteen (19) members of ARA's TRMG provided DHS Science and Technology (S&T) Directorate with data collected from DHS-provided EDS scanning systems, using an array of threats, including military and HMEs. This effort was in support of a major explosive detection acquisition by DHS, in conjunction with the Transportation Security Administration (TSA). DHS used this contract vehicle as a means of keeping this effort going until a new longer-term contract was in place, which occurred in June 2012 (DTRA L00066-00041).



Figure 1. TRMG Explosive Detection Systems Data Collection

3.2. Explosive Detection Systems Data Collection (EDSDC)

During the development of the TRMS, located on TAFB's Silver Flag Exercise Site. In coordination with the AFCEC Contracting Officer's Representative (COR), ARA's DHS client instructed TRMG to use this contract as a means of completing some of the site development tasks prior to the TRMS achieving operational status. The remaining effort conducted by the contractor consisted of the DHS/NIST support, Bomb Squad Robotic Training Standards (BSRTS), and AFCEC support for small robot acquisition, neither of which involved HME data collection efforts.



Figure 2. TRMG Site Development

3.3. DHS/NIST Support (Bomb Squad Robotic Training Standards)

In August 2013, DHS S&T (Standards Capability Development Office) tasked ARA to assist in the effort to develop robotic operator training standards. Under the program direction of DHS, ARA worked in close coordination with the NIST to produce robotic test methods, as a means of evaluating first responder robot operators and robotic platforms in order to provide data to develop standards meeting American Society for Testing and Materials (ASTM) criteria. During the course of this effort, ARA produced and delivered test methods for many municipal, county and state first responder agencies such as police and fire departments, and federal agencies (Table 2), and supported multiple DHS-sponsored training and demonstration events. ARA also produced a custom bomb squad test method for the Afghani National Police in Kabul, Afghanistan (Figures 3 and 4).

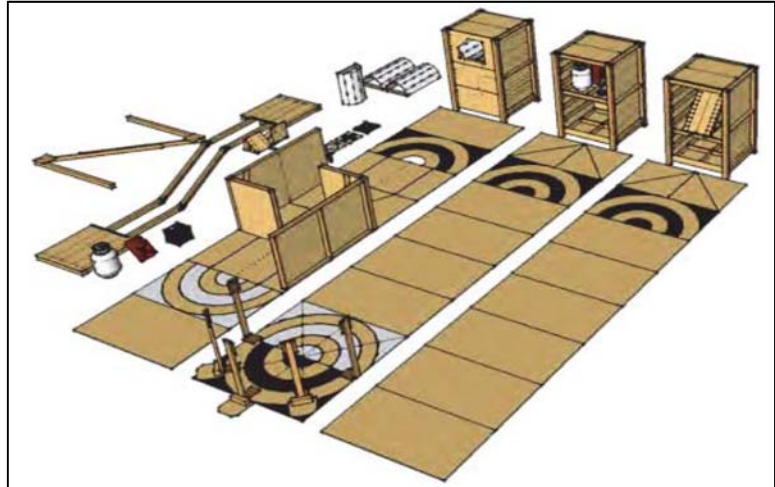


Figure 3. Layout of the Bomb Squad Test Method for Afghanistan



Figure 4. Shipment of Test Method Suite Being Unloaded in Kabul, Afghanistan

Table 2. ARA Support to NIST (chronological)

Year	Mon	Description
2013	Aug	ARA receives DHS funding to support NIST
	Dec	Tasked to support NIST at DARPA Robotic Challenge, Miami, FL (constructed multiple test/demo apparatus)
2014	Feb	Provided support to NBSCAB Commander's Conference, Gaithersburg, MD, constructed a full test method kit
		Tyndall AFB (AF Civil Engineering Center) agrees to transfer building 9720 to ARA for their use in supporting NIST
	Apr	Facility modification work is approved by the AF
	May	ARA employees attended NIST robotic test evaluation training, Gaithersburg, MD
	Aug	ARA provided four complete robotic test method kits to support NBSCAB training conference in Huntsville, AL
	Oct	ARA completed construction and shipment of a complete robotic test method kit for the Afghanistan National Police in Kabul, Afghanistan
	Nov	ARA supported NIST by providing four complete robotic training method kits for the California regional test center in San Diego, CA, with 5 ARA employees travelling to support this major event
	Dec	Completion of the overhaul of building 9720 on Tyndall AFB for ARA to support NIST
2015	Jan	ARA provides a full robotic test method kit for the NBSCAB training event in Gaithersburg, MD
	Mar	ARA supports the NIST-sponsored Raven's Challenge by providing four complete robotic test method kits for Denver, CO, Jacksonville, FL, Oriskany, NY, and Elma, WA
	Apr	Program support suspended (waiting new funds)
	Oct	Funding in place, ARA began work to provide one full robotic test method kits for Atlanta, GA Police Department
2016	Jan	ARA provided complete robotic test method kits for Olathe, KA Fire Dept, Phoenix, AZ Police Dept, and Santa Clara, CA Sheriff's Dept
	Ma	Provided two complete robotic test method kits for the Detroit, MI Police Dept, and Michigan State Police headquarters in Lansing, MI
	May	Provided complete kit for Western U.S. Robot Rodeo, Los Alamos, NM
	Jul	Provided complete kits for Eugene, OR Police Dept and Jefferson County, CO Sheriff's Dept
	Aug	Provided complete kits for Eastern U.S. Robot Rodeo, Dobbins AFB, GA; Cincinnati, OH Fire Dept
	Sep	Provided complete kits for Lee County, FL Sheriff's Dept; Houston, TX Police Dept; Las Vegas Metro Police Dept

3.4. AFCEC Support (Small Robot Acquisition)

In March 2015, AFCEC tasked ARA to assist in their acquisition of a small EOD robot. AFCEC invited several robotic system manufacturers to submit candidate robotic systems to undergo a series of tests over a 2-week period at Tyndall AFB. The robots were required to navigate a

predesignated course, performing specific tasks along the way, with each task being evaluated according to pre-established criteria. ARA personnel constructed the course according to AFCEC requirements and collected the performance data on all candidate robotic systems. All data were provided to AFCEC, as the robotic course, located in building 9720, 9700 area, Tyndall AFB, FL.



Figure 5. AFCEC EOD Small Robot Course

3.5. DHS/NIST Technical Specifications

Upon approval from DHS, the NIST program manager would send ARA the technical details (test method assembly guide, technical specifications, cut sheet, parts list), along with the receiving agency's information and requested delivery data for the completed test method. Once ARA reviewed this information, NIST and ARA would conduct a joint teleconference, and discuss all aspects of the tasking, including any changes that had been identified or were pending. Once ARA was ready to proceed with that particular task, ARA (contractor program manager) would prepare a Plan of Execution (POE), which was reviewed and signed by the DHS program manager (a copy of a POE is located in Appendix A). The POE served as ARA's notice to proceed, and the work to complete this task would begin. Once the building of the test method had been completed, and the test method had been delivered, ARA would notify the DHS program manager, and the process would begin for the next task order. An example of required materials for a seven lane kit is listed in Table 3, and Figures 5 – 9 show pictures of test method layouts, and robots during a test.

ARA employed procedures established by DHS and the TSL in the performance of the home HME data collection portions of this effort. Most of the procedures employed in support of this effort are classified or distribution of these documents are strictly limited. Similarly, NIST controls all distribution of the procedures and standards associated with the Bomb Squad Robotic Training Standards (BSRTS) portion of this effort. Procedures and all specifications used to complete the AFCEC small EOD robot task were provided to and remain the property of AFCEC.

Table 3. Example Material List for a Seven Lane Suite

Lumber	Qty	Miscellaneous Cont'd	
4' x 9' x 7/16 OSB plywood panel	55	chain	24
4' x 8' x 7/16 OSB plywood panel	145	medium binder clips	16
4' x 8' x 5/8 OSB plywood panel	14	carabiners	16
4' x 8' x 3/4 OSB plywood panel	9	timers	2
4 x 4 - 8' post	112	4" boxes	3
2 x 4 - 8' stud	446	6" boxes	3
2 x 6 - 8' stud	4	25lb. Magnet	2
2 x 10 - 8' stud	8	3/4"x3" nipple	4
2 x 12 - 12' stud	4	3/4"x6" nipple	2
1 x 12 - 4' stair treads	10	3/4" tee	2
Hardware		3/4" flange	2
3" screws, 25 lb carton	2	water bottles	2
1 5/8" screws, 25 lb carton	2	1/8" trimmer line- ft.	20
12 x 1" screws, 25 lb carton	22	3/8" rope - ft.	20
3/16" fender washer	16	blue duct tape - ft.	4
5/16" eye bolts	4	paint tray's	5
1/2" screws	500	painters pole	1
t-nuts	16	3" paint roller	5
cap screws	32	9" paint roller	5
3/8" oversized washers	26	1" foam brushes	50
hinges 3.5 x 3.5 set of 2	10	18 ga. tie wire ft. x-ray blocks	30
6" bolt latches	12	24" sonotube - 12'	28
4" L-brackets	48	5 lb. weights	2
door handles	4	10 lb. weights	5
2" threaded plug	29	2.25" circle labels	200
2" plugs	25	8" x 11" full sheet labels	50
#11 rubber stoppers	25	Paint	
1 1/4" trap adaptors	25	white paint - gal.	3
Miscellaneous		black paint - gal.	3
4 x 8 -1/2" drywall	1	blue paint- gal.	1
4 x 8 - 1/8" aluminum sheet	2	red paint - gal.	1
4 x 8 -1/16" steel rod	4	PVC	
alum yard stick	4	4" sch.40 pipe - ft.	20
prehung door	2	2" sch.40 pipe - ft.	50
4' pylons	2	1.5" sch.40 pipe - ft.	10
2" seat belt strapping	130	4" PFTCP caps	33
10x10 tempered glass	16	3" PFTCM caps	2
1/2" re-bar - 20 ft.	3	2" PFTCK caps	200

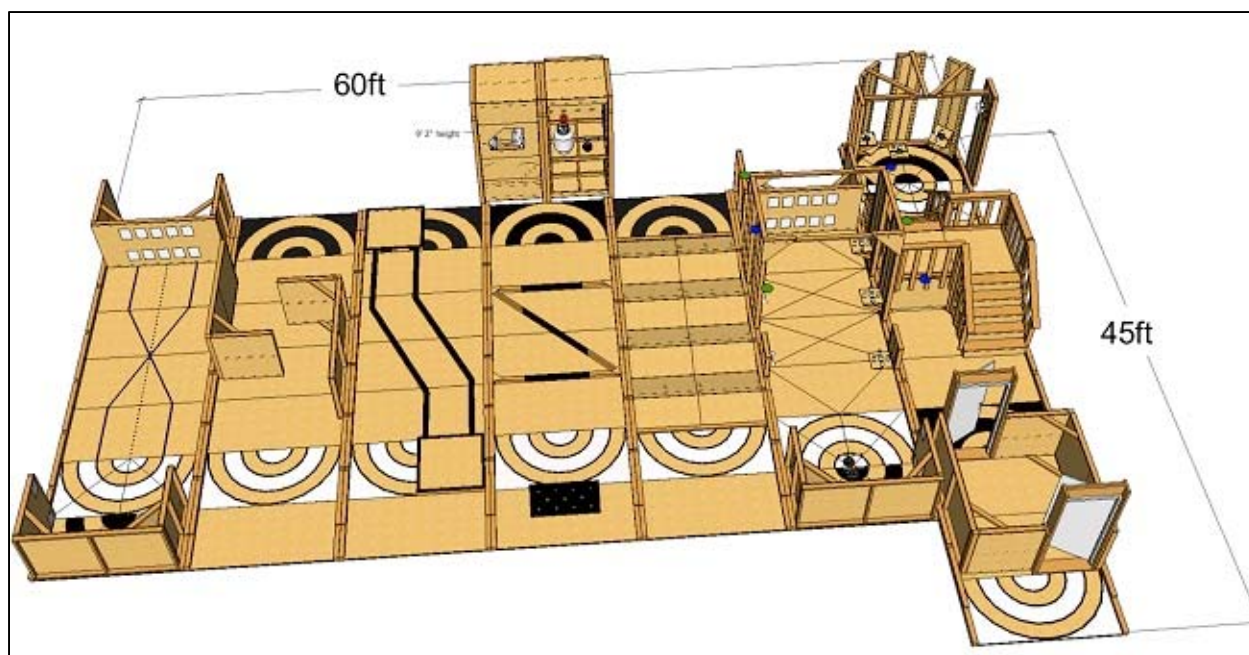


Figure 6. NIST Layout Sketch for the Raven's Challenge Test Method

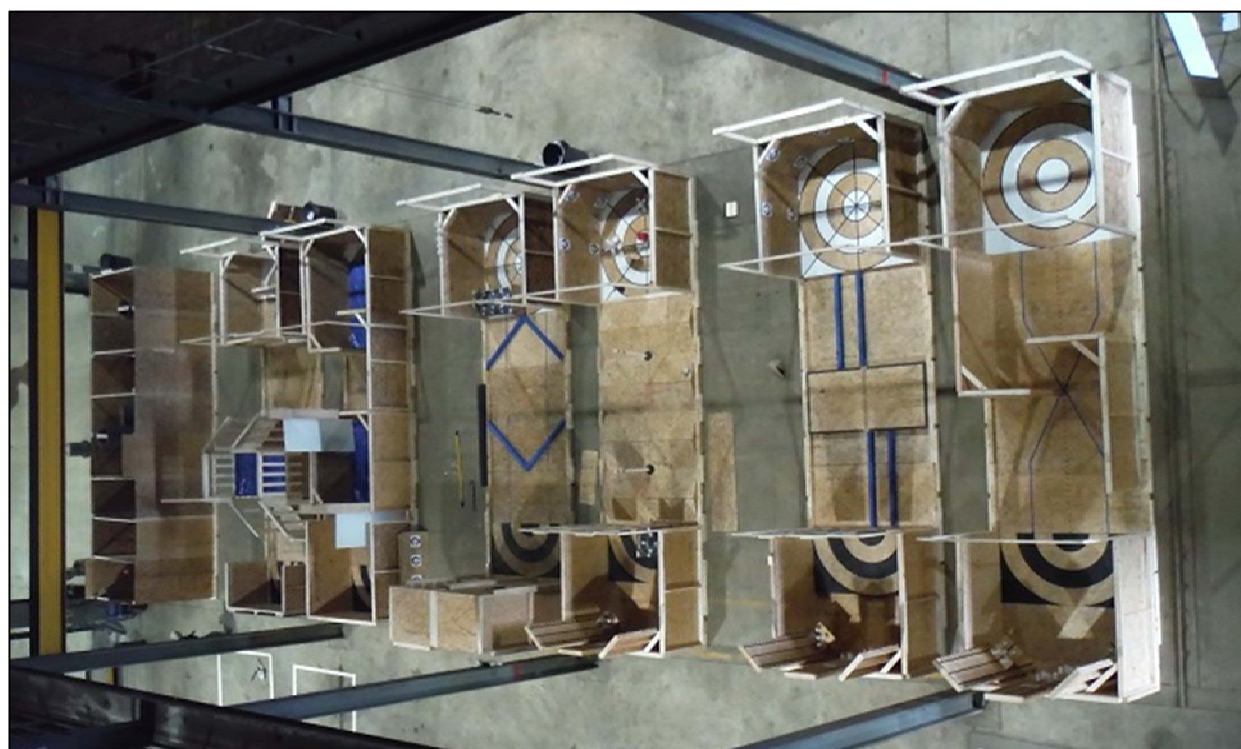


Figure 7. Finished Product, Seven Lane Test Method



Figure 8. Robot Proficiency Test Methods in Huntsville, AL

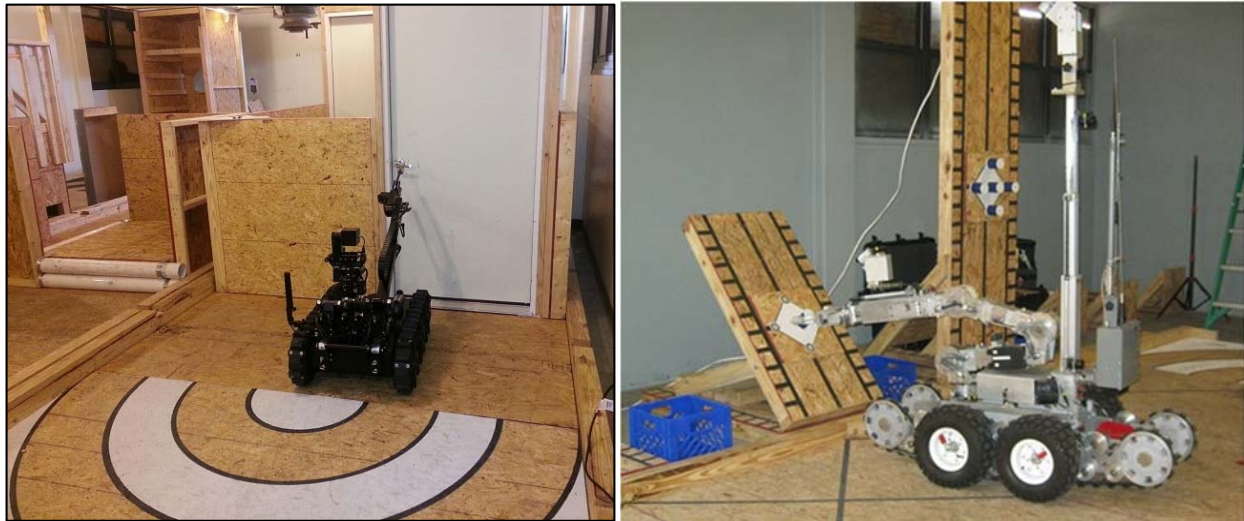


Figure 9. Operator Proficiency Test Methods in San Diego, CA

4. Conclusions

The BSRTS program was a research and development program designed to provide first responder robot operators with standardized criteria for navigating very difficult problems, from disasters ranging from the Fukushima nuclear plant in Japan, complex search and rescue operations over rough and unstable terrain, to neutralizing improvised explosive devices in more traditional law enforcement settings. As such, a large number of data points were WAS collected, and the NIST program office had the task of attempting to sort through these data points, and attempt to make sense of which ones should be used as part of the development of the robot standards. It is understandably a complex and dynamic challenge, and the end result was that ARA often received one set of instructions for the design of a particular part of a test method (i.e. built to a particular specification, constructed of a particular type of material, located on the test method at a particular height, angle, etc.), and would begin constructing the test methods to these specifications, only to have the specifications change multiple times before the test method was completed, or a decision by NIST would be delayed until the program manager could wade through all the data and make a final decision. .

5. Recommendations

5.1. Test Method Design Changes

When NIST develops a specification for a particular test method, they should consider instituting a “lock down” period, wherein no substantive design or material changes can occur until these test methods can be manufactured and tested against the NIST standards.

5.2. Method for Building and Assembling

When possible, the contractor should build and assemble as many test methods (same configuration) as possible to optimize material expenses

5.3. Combining Shipments

Optimize shipment logistics. ARA often shipped test methods to multiple receiving agencies in the same geographical area. This is primarily a cost consideration but it can result in a fairly significant savings of program resources.

5.4. Communication with NIST

Maintain regular contact with the NIST program office, especially when preparing to ship test methods. NIST can assist with coordinating with the receiving agencies and can verify that the test methods being shipped are aligned with what NIST and the receiver is expecting.

5.5. Communication with Receiving Agencies

Ensure that all receiving agencies are well aware in advance of the delivery and the adequate equipment that is needed for offloading and setting the test equipment.

5.6. Video Guide Instructions for Assembly

NIST should produce (or task a vendor to produce) a video that demonstrates the proper assembly and setup of the various base test methods.

6. REFERENCES

1. National Institute of Standards and Technology. *Apparatus Assembly Guide for Operator Training and Proficiency Evaluation*, ASTM E54.08.01, Ver. 2015.10.2

Appendix A: Plan of Execution

Plan of Execution (POE) #4 for

Interagency Agreement (IAA) HSHQPM-15-X-00111

Overview: Applied Research Associates, Inc. presents this plan of execution for your review and approval in support of the above referenced IAA between the DHS and the AFCEC. The only current task under this IAA deals with supporting the National Institute of Standards and Technology (NIST) in assisting in the development of standardized robotic test methods for training bomb squad robot operators. A complete test method is normally comprised of seven separate lanes for robots to navigate. ARA was advised that ten bomb squads across the U.S. will receive portions of a test method. The first four of the ten bomb squads have been identified as the first recipients of the partial test methods that TRMG will produce, along with a test method to be used in support of the Western U.S. Robot Rodeo, to be held in Las Cruces, NM (Los Alamos National Laboratory). The remaining five bomb squads (along with the specific portions of the test method they will receive) will be identified in a future communication from the NIST test director, and will be subject to the approval of the DHS program manager (Mr. Kai-Dee Chu), and will be dependent upon available funding.

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Details of current task:

- ARA will provide designated portions of the bomb squad test method (referred to hereafter as "test kits") to the below listed bomb squads, identified by NIST program office. These bomb squads are attached to the following law enforcement agencies or activities:
 - Western U.S. Robot Rodeo (Los Alamos National Laboratory)
 - Denver (CO) Police Dept
 - Lee County (FL) Sheriff's Office
 - Cincinnati (OH) Police Dept
 - Las Vegas (NV) Metropolitan Police Dept
- ARA will complete the portions of the test kits, and ship them to the points of contact at both law enforcement agencies.
- ARA estimates 5-7 weeks to construct, pack and ship to these agencies from the date of approval of DHS program manager.

Request DHS Program Manager approve POE #4, and notify ARA (Mr. Bruce Hebert) via email upon approval.

ARA will advise the DHS Program Manager when NIST has requested additional support, and will route this request through Mr. Chu for his approval via POE. All program updates will be provided via the monthly status reports, and as requested by the DHS PM.

Please contact me if you have any questions regarding this plan of execution, and please indicate your approval for us to execute this plan. Thank you.

LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

AFCEC	Air Force Civil Engineer Center
ARA	Applied Research Associates, Inc.
BSRTS	Bomb Squad Robotic Test Suite
COR	Contracting Officer's Representative
DHS	Department of Homeland Security
EDS	Explosive Detection Systems
EDSDC	Explosive Detection Systems Data Collection
EOD	Explosive Ordnance Disposal
HME	Home Made Explosive
NIST	National Institute of Standards and Technology
OSB	Oriented Strand Board
POE	Plan of Execution
POP	Period of Performance
TAFB	Tyndall Air Force Base
TRMG	Tyndall Reactive Materials Group
TRMS	Tyndall Reactive Materials Site
TSA	Transportation Security Administration
TSL	Transportation Security Laboratory